DRAFT LANGUAGE CHANGES TO ADDRESS DISPUTE RAISED BY TECK

Teck suggested changes in yellow

Additional EPA suggested changes in blue

4.3 AQUATIC INVERTEBRATES

Assessment Endpoints: Survival, growth, and reproduction of aquatic invertebrates

Risk Questions Working Hypotheses. Are the levels of contaminants in surface water, sediments, porewater, and invertebrate tissues greater than benchmarks for the survival, growth, or reproduction of aquatic invertebrates? Is the survival, growth, or reproduction of benthic invertebrates exposed to UCR sediments unacceptably lower than that for benthic invertebrates exposed to reference sediments? Benchmarks used to determine TRVs will, as determined by EPA, include, but are not limited to: sediment quality guidelines and regulatory standards, ~~derived toxicity thresholds,~~ concentration-response relationships, and water quality criteria.

Risk to aquatic invertebrates will be assessed quantitatively for those chemicals for which there is information on surface water, sediment, or porewater concentrations that result in adverse effects. Certain COPCs do not have such information, so risks from these COPCs will be addressed in the uncertainty analysis.

Receptors. A summary of benthic macroinvertebrate surveys conducted in the UCR is presented in Appendix A of the BERA Work Plan (TAI 2011). Species selected for bioassays will be evaluated to ensure that they are sufficiently sensitive to be protective of the major invertebrate species of concern such as amphipods, trichoptera, plecoptera, oligochaetes, ephemeroptera, and mussels. Selection will be made in consultation with EPA, but will include *Hyallela azteca* and *Chironomus dilutes* and may, in consultation with EPA, include a freshwater mussel such as *Lampsilis siliquoidea*.

Candidate Measurement Endpoints. Concentrations of COPCs in surface water, sediment, toxicity-test porewater, and invertebrate tissue compared to benchmarks, including the results of laboratory bioassays (see below). Survival, growth, biomass, and reproduction of benthic invertebrates in laboratory toxicity tests. .

Analysis Plan: Toxicity. Benthic invertebrates will be assessed using multiple lines of evidence that address different exposure pathways. Proposed methods are described below. Epibenthic and infaunal invertebrates will be assessed using a multi-step approach. The first step will use existing sediment quality values and chemical data to rank sediment stations in the UCR over appropriate, as determined by EPA, concentration gradients with consideration of sediment classes. Bioassays will also be conducted at stations representing observed gradients and sediment types. Slag-enriched sediment has been identified as one specific sediment class that will be evaluated. Sediment chemistry and bioassay results will be used with the intent to

develop toxicity thresholds and predictive concentration-response models of chemistry-to-effects to assess risk from bulk sediment at other site locations (adjusted for bioavailability differences, as appropriate). In addition, *H. azteca* tissue at the end of the 28 day tests will be archived and may be analyzed, at EPA's direction, to provide a supplemental line of evidence. (EPA would NOT add this language here)

Sediment exposures of benthic organisms will include measures of porewater concentrations to determine whether a predictive site-specific relationship can be developed between the chemistry and toxicity data. Pore-water quality will be monitored at appropriate intervals and using technology determined in consultation with EPA. The pore-water chemistry measurements provide data needed to apply the biotic ligand model to evaluate metal toxicity in sediment pore water.

Data collection activities will be conducted in future sampling events to fulfill the data requirement for the above approach, as described herein. It is not possible to determine the precise number of samples that need to be collected to support the development of reliable concentration-response models a priori; however, 100 to 130 sediment toxicity-test samples is the initial target for planning purposes. Following each round of testing (e.g., 25 to 50 samples per batch, including reference stations), the resultant data will be examined and evaluated to determine if more data are required and to specifically identify data gaps to be filled in the subsequent batch of toxicity testing (i.e., to identify the data needed to develop concentration-response relationships sufficient for risk determination). Interpretations of the resultant sediment toxicity data will need to recognize that relationships between toxicity and chemistry may vary among different types of sediment samples that occur within the study area.

Surface sediment grab samples will be collected from approximately 50 stations in Round 1 sampling, to be agreed upon in the sediment QAPP. Stations will be selected to represent gradients of COPC concentrations (e.g., mean probable effects concentration quotient [mPECQ], a measure or estimate of the percent slag, and bioavailability measures (e.g., total organic carbon [TOC]). Other considerations informing sample location selection will include concentrations of non-slag COPCs, sediment types, and past sampling experience. The sample station selection process also may include the use of geostatistical tools, which will be updated as needed following each of the required rounds of testing. Spatial aspects of sample locations (e.g., lateral position of sampling location in river, longitudinal sedimentation position [e.g. riverine, lacustrine or transitional river reach; bathymetric and depositional zones]) will also be recorded as factors for analysis. Sediment and porewater chemistry will be measured in all samples (to the extent practicable for field samples of porewater), with the list of analytes to be determined in consultation with EPA. Whole-sediment bioassays using the amphipod *H. azteca* and the midge *C. dilutus* will be performed on splits of samples collected. Sediment samples will have material greater than 2 mm removed.

Specifically, bioassays to be performed include:

- 10-day whole-sediment toxicity tests with the midge, *C. dilutus* (endpoints survival, weight, and biomass; USEPA 2000; ASTM 2011a)

- 28 day whole-sediment toxicity tests with the amphipod, *H. azteca* (endpoints survival, weight, and biomass; USEPA 2000; ASTM 2011a).

In addition, reproductive endpoints will be assessed on at least 12 split-samples. These split-samples will be selected to include those stations with moderately to highly elevated metal concentrations. Specific bioassays to be performed on these 12 samples will include:

- 50-to-65-day whole-sediment toxicity tests with the midge, *C. dilutus* (endpoints survival, weight, emergence, number of eggs/surviving female, number of egg cases, egg hatching success, viability of young; using the adapted method starting with 7-day old larvae; USEPA 2000; ASTM 2011a). Additional recommended endpoints include biomass, the number of eggs produced per replicate chamber, and the number of eggs per egg case

- 42-day whole-sediment toxicity tests with the amphipod, *H. azteca* (endpoints survival, weight, biomass, neonates/surviving female; USEPA 2000; ASTM 2011a).

In consultation with EPA, additional lines of evidence may be necessary which could include a freshwater mussel whole sediment toxicity test (e.g., the 28-day *Lampsilis siliquoidea* test with endpoints of survival, weight, and biomass; US EPA 2000, ASTM 2011a,b).

Results from the bioassays will be used to evaluate if there are significant differences in the survival, growth, or reproduction of benthos exposed to Site and reference sediments. If significant differences are identified, these data will be used to evaluate a) the magnitude of effects; and b) the relationship between COPC concentrations and observed effects. These results will also be used to evaluate the relative value of respective bioassays for future sediment sampling efforts. If meaningful concentration-response relationships can be developed, they will be used to classify each sediment sample from the UCR relative to the risks posed to benthic invertebrates. Such risk classifications will include the methods of MacDonald et al. (2009). Importantly, the evaluations based on surface-water chemistry and pore-water chemistry will also be considered in the risk classification system. Should significant responses be identified in the bioassays that are not clearly attributable to previously measured factors, or are inadequate for remedial decision making, further evaluation (e.g., toxicity identification evaluation [TIE]) will be considered and may be required by EPA to discern if the observed effects are due to certain classes of COPCs. TIEs would be conducted according to EPA guidance and studies reported in the scientific literature (e.g., USEPA 2007; Hockett and Mount 1996). For this project, concentrations of COPCs would be measured in the tissues the *H. azteca* at the end of the TIE toxicity tests to provide another line of evidence for interpreting the toxicity test results.

Analysis Plan: Bioaccumulation. Invertebrate tissue chemistry represents an important line of evidence for evaluating risks to benthic invertebrates associated with exposure to COPCs in the study area. More specifically, data from laboratory bioaccumulation tests provide information

on the bioavailability of sediment-associated COPCs and on their accumulation in invertebrate tissues. Matching tissue chemistry and sediment toxicity data from laboratory toxicity tests can provide the information needed to identify critical body residues (CBRs) of COPCs. In turn, this information can be used to interpret field-collected invertebrate tissue chemistry data.

To support the development of site-specific measures of toxicity at the UCR Site, 28-d whole-sediment toxicity tests will be conducted using sediment samples from the UCR representing a broad gradient of COPC concentrations, slag content, and organic carbon concentrations. In addition to measuring the survival, growth, and biomass of the amphipod, *Hyalella azteca*, ~~three~~ two indicators of exposure to COPCs will also be measured, including:

- Whole-sediment chemistry (<2.00 mm size fraction);

- Pore-water chemistry (e.g., with pore-water samples obtained from peepers placed in replicate exposure chambers and by centrifugation of sediment samples); and,

- ~~Invertebrate tissue chemistry (with tissue samples obtained from additional replicate exposure chambers to provide the requisite tissue mass for analysis).~~

The body of data from these specific tests and analyses will support interpretation of the sediment-toxicity studies, ~~estimation of any needed bioaccumulation factors /functions (e.g., Biota Sediment Accumulation Factors [BSAFs]),~~ and development of relationships between exposure to COPCs and the responses of benthic invertebrates. Concentration-response relationships for whole-sediment and/or porewater are expected to provide site-specific lines of evidence for evaluating risks to benthic invertebrates associated with exposure to contaminants in whole sediment and/or porewater in the UCR.

It is understood that not all benthic invertebrates derive their exposure to COPCs via the same exposure pathways. For this reason, benthic invertebrates will be collected from various locations in the UCR and subjected to chemical analysis. While the resultant invertebrate tissue data will be used primarily for food-web modeling (i.e., estimating average daily doses of COPCs for higher trophic-level receptors), these tissue data may also be used as a supplemental line-of-evidence for assessing risks to certain benthic invertebrates (e.g., ephemeroptera, plecoptera, and trichoptera [EPT] taxa). Co-located sediment samples will be collected with the field-collected invertebrates to support modeling from sediment up the food chain. ~~More specifically, a comparison of field-derived measures of benthic exposure to COPCs (i.e., invertebrate tissue chemistry) with laboratory-derived measures of CBRs can provide another line of evidence regarding the potential for adverse effects on UCR benthic invertebrates from exposure to site-related COPCs. To this end, site-specific relationships between both field and laboratory collected invertebrate tissue chemistry and laboratory based toxicity data of benthic invertebrates would be evaluated, along with relevant literature based data, with the intent to develop tissue based species sensitivity distributions and/or CBRs for selected COPCs.~~